AD 746144

ONR LONDON REPORT

R-9-72

OFFICE OF NAVAL RESEARCH

BRANCH OFFICE LONDON ENGLAND

SOME ASPECTS OF PHYSIOLOGICAL RESEARCH IN SWEDEN AND FINLAND

R.R. SONNENSCHEIN

13 June 1972

UNITED STATES OF AMERICA

20

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Office of Naval Research Branch Office London	2a. REPORT SECURITY CLASSIFICATION 2b. GROUP

3. REPORT TITLE

SOME ASPECTS OF PHYSIOLOGICAL RESEARCH IN SWEDEN AND FINLAND

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

Ralph R. SONNENSCHEIN

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
13 June 1972	13	26

8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) ONRL:R-9-72 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

This report summarizes some of the physiological research being carried out in Sweden, at the Universities of Lund, Göteborg and Umeå and at Karolinska Institutet in Stockholm; and in Finland at the Universities of Helsinki and Turku and at the Institute of Occupational Health in Helsinki.

DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
cardiovascular physiology vascular smooth muscle cardiovascular reflexes capillary flow capillary transport adipose tissue mast cells gastrointestinal physiology neurophysiology endocrinology thermoregulation detoxification						

SOME ASPECTS OF PHYSIOLOGICAL RESEARCH IN SWEDEN & FINLAND

For many years Sweden has been a leader in physiology as well as in other preclinical medical sciences. This has reflected generous governmental support over the years for research and education, fostered at least in part by the fact that Sweden was neutral during WWII and hence did not have the drain on financial and personal resources suffered by other countries. The overall enthusiasm and rigor of approach which I had observed on two occasions in the past when I spent a year in Sweden on sabbatical leave, is still quite obvious.

Finland too, while smaller and less wealthy, has a long tradition of excellence in physiology dating back to Tigerstedt at the beginning of this century. While each country stands on its own, there is, as for much of the past, a great deal of intellectual and cultural exchange between them.

This report will outline some of the observations I made during a trip in December 1971 when I visited a fraction of the physiological laboratories in these two countries. These notes can give only a flavor of the very broad and active research going on at the present time.

I. SWEDEN

A. Lund

The Institute of Physiology at the University of Lund has a long and illustrious history. Until recently it was headed by Professors Nils Emmelin and Georg Kahlson. Kahlson has now officially retired although he maintains an office at the Institute and continues with his interest in histamine. The Department is now jointly headed by Emmelin and Professor Stefan Mellander, who came to Lund from Göteborg about two years ago. The two professors alternate in handling the administrative affairs of the department. In addition to Emmelin and Mellander, I visited and discussed research with Associate Professor Börje Johansson.

Johansson, who also came to Lund from Göteborg about a year ago, has been interested for some time in the properties of vascular smooth muscle, particularly in the mechanisms of neuromuscular transmission therein. He had previously contributed importantly to the question of myogenic transmission in vascular smooth muscle, working almost

entirely on the portal vein of the rat. With Olov Jonsson, he studied the role of osmolarity in relaxation of the blood vessels and related this to the idea which Mellander has proposed (see below) that tissue osmolarity may be an important factor in the relaxation of blood vessels in skeletal muscle during exercise.

Johansson's interest now is chiefly in electromechanical coupling and the role of calcium ion and depolarization in this phenomena. The concentration of calcium inside the cell is directly dependent upon the level of extracellular calcium ion and can therefore be manipulated by changing the latter. With a sufficiently decreased extracellular calcium it is then possible to depolarize the cell with high external potassium, but with no ensuing contraction. From consideration of the extent of depolarization as a function of external calcium ion and analysis of the kinetics of this reaction, Johansson has calculated that a hypothetical receptor combines with two molecules of calcium. Such analysis is much simpler in the case of smooth muscle cells than with cardiac or skeletal muscle, since very little calcium is stored within the muscle cells.

Johansson is also beginning to investigate the mechanical characteristics of contraction of smooth muscle. Previously all such studies had been done on essentially isometric contraction. Johansson is now working on a system for recording isotonically, and determining the force-velocity relations. Podolsky has reported that in the skeletal muscle the relation of V to the ratio of $\frac{P}{P_0}$ is independent of changes in external calcium ion. From this he concluded that the concentration of calcium affects the number of cross bridges activated but does not affect the rate of reaction of the individual contractile elements. Johansson has found essentially the same thing in an isolated smooth muscle, i.e., that the relation of V to $\frac{P}{P_0}$ is the same in high calcium (2.5 mM) as it is with low calcium (0.4 mM).

Mellander, along with his graduate student, Jon Lundvall, has continued with studies begun some years ago on the role of tissue osmolarity in exercise hyperemia. He has recently looked at the time factor, that is, the rate and extent of hyperosmolarity as a function of hyperemia, and finds that vascular conductance and venous osmolarity are correlated particularly in the first five minutes of

exercise. He finds that 80% of the fluid which accumulates in the muscle during exercise can be attributed to the osmotic factor, while increase in capillary hydrostatic pressure apparently can account for only 20%.

Mellander has also been working on the role of plasma osmolarity in the regulation of plasma volume during exercise. He had found earlier in experiments on cats that with maximal exercise edema formation in muscle may be as much as 150 ml/1000 g of tissue. In recent experiments on human subjects pedaling a bicycle ergometer at a high work level, in the first six minutes, before sweating occurs, there is a maximum uptake of water into the exercising muscle of the order of 45 ml/1000 g of tissue. When extrapolation is made to the whole body mass of muscle of approximately 25 kg, this would indicate a loss from plasma of 1200 ml of water. The actual loss during total body exercise in the six-minute period is only about 600 ml of plasma. During this same time arterial osmolarity increases by about 25 milliosmol. Accordingly, Mellander reasons that this increased arterial osmolarity tends to draw fluid from tissues other than the exercising muscle, thus reducing the loss. The remainder may be retrieved as a result of reflex arteriolar constriction and decrease in capillary pressure. In hemorrhagic shock an increase in plasma osmolarity of the order of 40 milliosmol may also occur. This is apparently brought about to the hyperglycemia resulting from adrenal activation decrease in insulin tolerance. It appears that this osmotic factor is considerably more important than reflex effects during hemmorrhage.

A further topic that Mellander has been investigating is the response of blood vessels to rate of change of distending pressure. Experimentally, when mean profusion pressure is sustained, there is an increased myogenic response if the pulse pressure is increased. Mellander postulates that this mechanism may be involved in the genesis of hypertension. If, for example, otherosclerosis of the large arteries takes place, this would reduce the Windkessel effect, increase the pulse pressure, and bring about an increased myogenic constriction of the peripheral vessels and hence increased resistance. In turn, mean pressure would tend to rise as a result of the increase in peripheral resistance, and this would act to cause increased myogenic response, thus initiating a vicious circle. Mellander admits this to be still in the realm of speculation.

Emmelin has recently been working on the myoepithelial elements of salivary glands in various species (see Appendix, refs. 1,2,3). These have both cholinergic and adrenergic innervations, which are parasympathetic and sympathetic, respectively. Contraction of the myoepithelial elements contributes up to 60 mm Hg pressure in a closed salivary duct during neural stimulation. This is true even in those cases where, after prolonged duct ligation, the secretory elements have been destroyed. He is currently writing a review with Trendellenburg on the so-called "Degeneration Effect" which is not to be confused with "paralytic secretion," an example of denervation hypersensitivity, but rather is the appearance within about 10-24 hours of denervation of an increased responsiveness of the organ. The delay is directly related to the length of nerve left at the section. This suggests that the phenomenon depends on the movement from the point of section of some substance down the nerve to the end organ.

I also had a brief visit with Dr. Paul Edman in the Institute of Pharmacology at Lund. He has an outstanding setup for his unique experiments on the contractile properties of single muscle fibers from frog muscle and for similar experiments on isolated small bundles of cardiac muscle. Not only can he work with the single fibers to examine force-velocity relations and electrical activity with microelectrodes, but he is even able to monitor sarcomere length continuously. This he does by using the muscle fiber itself, which has an extremely high regularity in sarcomere orientation, as a diffraction grating; a laser beam is the light source. He can determine changes of the order of 25 Å which corresponds to about 0.2% of sarcomere length. I did not have time to talk with him in detail about his experiments, which are well known in the literature.

B. Göteborg

The Department of Physiology of the University of Göteborg consists of two divisions. One is headed by Anders Lundberg, whose field is central neurophysiology, the other by Björn Folkow, whose interests are in the peripheral circulation. Both divisions are outstanding for the quality of their research and have attracted many foreign research workers. On this trip I visited only in Folkow's division where I had the opportunity of working for a year in 1964-65.

Folkow, himself, while having a very broad interest and being involved in many separate projects, his own and those of his collaborators, has been particularly interested in recent years in the problem of hypertension and the changes in peripheral vessels which accompany the genesis of this condition. A good deal of his recent work has been on the so-called spontaneously hypertensive rat (SHR), a strain developed in Japan which shows a gradually appearing hypertension as the animals age. Through analysis of pressure-flow relationships and calculation of resistances, Folkow has deduced that the primary changes in the SHR reside in structural changes in the blood vessel walls, particularly in the wall to lumen ratio of the arteries and arterioles. These changes appear to be secondary to hypertensive episodes, presumably neurogenic, which occur in the rat and which then affect the structural characteristics of the vessels. Once these structural changes have occurred the hypertension then tends to be permanent as a result of the increased peripheral resistance. Folkow postulates that for the rats, as well as perhaps for essential hypertension in humans, the primary feature is a centrally induced increase in cardiac output (perhaps as a result of "stress"); the secondary vascular changes tend to make the whole process a permanent one (see references 4,5).

Peter Thorén, a graduate student working together with Dr. Bengt Öberg, has completed an intensive study on left ventricular receptors whose afferents are non-medulated vagal fibers. These receptors, which are distributed profusely throughout the superficial and deep layers of the ventricular myocardium, are activated by occlusion of the ascending aorta, by elevation of arterial pressure, or by rapid infusion of fluid, whenever these procedures produce an increase of ventricular end-diastolic pressure and volume. Activation of the receptors causes a reflex bradycardia and probably vasodilatation and fall in arterial pressure. Öberg and Thorén believe that this reflex mechanism may contribute to the homeostatic control of arterial pressure and blood volume, but that its main function seems to be to protect the heart from overloading. They believe these left ventricular receptors to be the main ones involved in the Bezold-Jarisch reflex. Thorén is preparing these results for his dissertation and two papers (Appendix, refs. 6,7,8) have been submitted for publication.

Dr. Ove Lundgren, who presented his dissertation in Folkow's department only a few years ago, has been continuing along with several younger colleagues his extensive work

on various aspects of intestinal circulation. Among these are the problem of plasma skimming in the intestinal tract, and regional distribution of red cells, plasma and blood volume in the intestinal wall. He has used refined isotope clearance techniques for some of these experiments including analysis of so-called counter-current exchange; currently he is interested in the counter-current exchange of fatty acids and glycerides. A recent phenomenon that Lundgren and co-workers have been investigating is the intestinal vasodilatation observed after mechanical stimulation of mucosa of the gut. This dilatation is not affected by atropine, adrenergic blocking agents, or ganglionic blocking agents. However, the increased blood flow is blocked by tetrodotoxin, by a local anesthetic, and by 2-bromo-LSD, a blocker of 5-hydroxytryptamine (5-HT). This suggests that the response is mediated via an intramural nervous reflex somehow dependent on the release of 5-HT (see refs. 9, 10).

In the Department of Surgery I, University of Göteborg, Drs. D.H. Lewis and K.L. Appelgren have completed an extensive study on relationship between capillary flow and capillary transport in skeletal muscle during hemorrhagic shock, and the effect on this of infusion of low-molecular-weight dextran. Appelgren is presenting this material for his dissertation; much of the results have been prepared for publication. Basically, Appelgren has used a double isotope technique to compare the flow and transport. This involves simultaneous injection into the tissue of labled xenon and labled iodide. The clearance of xenon is presumably related to total capillary flow whereas that of iodide, a substance which is diffusion limited, is taken as an index of capillary transport. Shortly after bleeding, a more efficient diffusional transport of iodide was seen where the flow was the rate limiting factor for transport. With the progression of shock the flow changed towards values slightly below control, but the transport of iodide was only some 40-50% that of the control. This disturbance in transport occurring with progressive hemorrhage is thought to be due to the more inhomogeneous distribution of flow through the capillary bed. A similar dissociation between flow and transport also occurred in experimental surgical shock (laparotomy and externalization of the small intestine) (see Appendix, refs. 11, 12).

C. Stockholm

1. The Department of Pharmacology, Karolinska Institutet

This Department, headed by Professor Börje Uvnäs, is one of the largest and most productive in several fields of physiology and pharmacology. Some of the areas covered and the names of workers in these fields are as follows: storage and release of biogenic amines (Uvnäs, B. Diamant, S.A. Slorach); neuro-psychopharmacology (Änggård, G. Sedvall, B. Sjöquist); circulation and metabolism (P. Bolme, S. Rosell); gastrointestinal physiology and pharmacology (S. Andersson); smooth muscle - active lipids (Änggård); clinical pharmacology (Sjöqvist).

In my brief visit to this Department I had the opportunity to talk with only a few of the many investigators. One was Sune Rosell whose chief collaborators at present are Lennart Edwall, and a visitor from the University of Virginia, Dr. John Gainer. Rosell has worked most recently on blood flow in adipose tissue and the regulation of release from adipose tissue of fatty acids. He had previously shown that the capillary filtration coefficient (CFC) of subcutaneous adipose tissue and that of the omentum are about three and five to six times, respectively, that occurring in skeletal muscle, and that the CFC increases with sympathetic stimulation. Gainer and Rosell now find that rubidium extraction decreases with sympathetic stimulation. The question then is: How does it come about that rubidium extraction, which reflects transport capacity, decreases, while CFC increases at the same time! One possibility is that the diffusion for the rubidium may change. Gainer is to try infusions of solutions with small amounts of albumin, which he has reason to believe may decrease permeability outside the capillary endothelium, and will use this to test this hypothesis of change in capillary permeability under the influence of sympathetic stimulation.

Edwall did an extensive set of experiments on the circulation in various oral tissues and the effects of sympathetic nerve stimulation on these. With tracer techniques he studied the gingiva, the dental pulp, the alveolar submucosa and the periodontal membrane. In all these tissues sympathetic stimulation resulted in decrease in tracer disappearance; this was apparently an alpha - adrenergic, action. He does not have information on the physiological circumstances during which the sympathetic vasoconstrictor outflow to the oral tissues is activated. He found further, from recording electrical activity in intra dental sensory units, that sympathetic nerve stimulation causes changes in the excitability of the dental

sensory unit, such that with such stimulation there was first an increase followed by a decrease in excitability (Appendix, refs. 13-14).

Professor Uvnäs has devoted a major part of his efforts for the past several years to the problem of the biochemistry and pharmacology of mast cells and the release of biogenic amines. He has shown that the release of histamine from mast cells exposed to the compound 48/80 occurs in two steps: (1) degranulation with passage of histamine-carrying granules to the exterior; and (2) an extracellular cation exchange from the granules between hystamine and sodium, resulting in a total release of the histamine from the extruded granules. He is currently looking at the composition of the protein in the granules and some quantitative aspects of its binding capacity. Through a great deal of work he has come to a general theoretical scheme for the release of biologically active substances from intracellular granules, and believes that this will hold for such mechanisms as release of transmitter substances from the endings of nerves.

Dr. Sven Andersson is continuing his active studies on regulation of gastric secretion, a field that has also been of interest to Uvnäs for many years. One of Andersson's main topics is the nature of the hormonal factor which leads to gastric inhibition in the presence of acid in the duodenum; his evidence, he feels, rules out secretin. In addition, Andersson is investigating the role of the intrinsic neural plexus of the pyloric antrum in the release of gastrin.

2. The Nobel Institute for Neurophysiology

In a brief visit with Dr. Curt von Euler, Associate Professor in the Nobel Institute for Neurophysiology, I learned a bit about his present work. He has been studying respiratory movement as a model for general control of movements. In all his experiments he monitors pertinent blood chemistry as an index of function. During contraction of the intercostal muscles, there is increased activity in the gamma efferent nerves with increased firing of spindles. This is not the case in the diaphragm which has very few spindles. This fact is correlated with the fact that the intercostal muscles are also postural muscles, but not the diaphragm. There is one system of gamma efferents from the cerebellum which are involved in posture; a second system of gammas which is involved in respiration converge on the same spindles. There is integration of these motor efferent impulses at the

segmented level. Among other questions in which von Euler is interested is that of the coupling between the intercostals and the diaphragm. He has also done an extensive analysis of the relationship of tidal volume and frequency when there is fixed demand from the chemoreceptors; through this analysis he has characterized the importance of the Hering-Breuer reflex.

D. Umeå

The Medical School of the University of Umeå is less than ten years old. The Department of Physiology has been headed by Prof. Sven Landgren for the past five or six years. Landgren, who had been in the Physiology Department at the University of Göteborg for many years, is well known for his work on receptors and central sensory mechanisms. His work now, much of it in collaboration with Dr. H. Sylfvenius, is directed towards understanding of central pathways and cortical projections of efferent information arising from muscle and tendon receptors. For instance, he has shown that the spindle efferents from the hind limb project to the border of the motor cortex. These may ascend with the dorsal spinocerebellar tract with a relay in the nucleus-Z in the medulla, thence by way of the medial lemniscus to the nucleus VPL, and finally to the cortex. The intereactions of these cortical projections with motor activity is one of the questions that Landgren is currently interested in. Another is whether Golgi receptors contribute to cortical potentials. He is attempting histological definition, along with functional, of the spindle efferent cells in the cortex by use of the intravital procion yellow staining technique. These are but some small details of the very extensive work which Landgren and his associates have been carrying out on sensory mechanisms, some details of which are presented in the publications in the Appendix (15, 16, 17).

A young man, Dr. Åke Vallbo, has been continuing the remarkable experiments which he started with Hagbarth of Uppsala University, recording from single afferent fibers in the median nerve of human subjects. With this technique he has been investigating problems of the relationship between receptor stimulation and preception on the one hand, and the time relationship of activation of muscle receptors during voluntary contraction. Through simultaneous recording of activity from muscle spindles of the electromyogram, he has investigated the question whether during voluntary contraction there is simultaneous excitation of the alpha and gamma motor neurons, or whether the fusimotor activity preceeds

the skeletomotor outflow (the so-called follow-up length servo hypothesis). He found, in fact, that muscle spindle acceleration regularly occurs after the onset of electromyographic activity. This, along with other details of the work, suggests that there is simultaneous excitation of the alpha and gamma neurons, and that during voluntary contraction the follow-up length hypothesis does not hold (see Appendix, refs 18, 19).

In addition to the predominantly neurophysiolgical work of the Department, endocrinological investigations are carried out by Dr. Carstensen. His work is concerned first of all with spermatogenesis, in which he is investigating the role of FSH as a controlling factor for the production of testosterone by the Leydig cells of the testes. His second interest is in the plasma levels of testosterone after surgery; he finds an early decrease which returns to normal in one to two weeks. LH in the plasma is apparently not related to this, but the question remains whether there is a change in binding of testosterone by plasma proteins.

This Department, very well equipped but small in staff, has shown remarkable growth and strength under Landgren's direction. The spirit in the Department, and I gather in the school at large, is excellent, and despite the relative isolation of Umeå in the north of Sweden, this is rapidly becoming an important and productive center for scientific research.

II. FINLAND

A. Helsinki

1. The Institute of Occupational Health

The Institute is currently headed by Professor Martti J. Karvonen, who until recently had been director of the research section of the Institute. The Institute's activities cover a very broad spectrum: teaching and education; publications of several types of reports; statistical, epidemiological and experimental approaches to various types of problems in industrial and social health matters. Among some of the topics in occupational health are effects of vibration on bones and nervous system, psychological and pathological effects of carbon disulfide and other industrial poisons, lead intoxication, and coronary heart disease among different types of workers. A large study has been going on for several years on the epidemiology and prevention of

coronary heart disease, and in this Karvonen has himself been especially active.

Physiological investigations have been carried out chiefly under the direction of Dr. P. Piironen. In a study of heat exchange between blood and tissue, the primary problem has been to determine whether regulation of heat production can be accurately accounted for in the steady state as well as in dynamic situations on the basis of hypothalamic and skin temperatures, or whether other factors may have an important influence in this regulation. Their analysis indicates that the gradient of skin temperature is also important in thermal regulation.

Unfortunately, my time at the Institute was too limited to gain an insight into further activities which are going on there.

2. The Department of Physiology, University of Helsinki

This is an old and very distinguished department. Its director at the turn of the century was Professor Tigerstedt, one of the leaders of physiology in his time. More recently the Department was headed by Professor Reenpaa who, although now retired, is still quite active and continues with his interest in some aspects of the philosophy of science. The present head is Professor M. Bergström.

The Department is housed still in its old quarters which apparently were at one time a private home. It still contains in many of its rooms very charming old tiled fireplaces, and throughout the building are cases containing old physiological instruments. Even though the building is old and the quarters are currently arranged in a rather haphazard manner, the equipment is generally very new and of high quality. Here, as in most laboratories in Scandinavia as well as through much of Europe, the Department has its own machine shop which produces much of the high quality instrumentation.

The Department is primarily neurophysiologically oriented. Bergström is interested in developmental and theoretical aspects of neurophysiology. For instance, through such studies as those on the transformation of neural-functioning in the seventeen-day chick (development of touch and vibration sense) and observations on reflex development, he has developed theoretical models such as are described in

a paper entitled, "An Entropy Model of the Developing Brain" (20). In addition to his work on developmental aspects of the vertebrate nervous system (21), Bergström has also investigated the organization of the central nervous system in coelenterates (22).

Dr. J. Hyvärinen, who recently worked with Vernon Mountcastle at Johns Hopkins University, has been working on operant conditioning in the monkey and the effects of "attention" on unit activity in the cerebral cortex and the thalamus. He finds some changes in the thalamus with attention, while in the somesthetic area of the cortex, activity in approximately 20% of units is correlated with attention. In the association area there is a convergence of sensory inputs. The work is summarized in the cited paper in the Appendix (23).

Dr. P. Putkonen, in association with Dr. H. Sarajas, has studied olfactory and hippocampal activity in association with temperature regulations in rabbits (24). More recently he has been investigating some aspects of sleep mechanisms (25). Sarajas has recently been appointed Professor of Physiology in the Veterinary College of the University of Helsinki, and will no longer be at the Faculty of Medicine.

Dr. M. Hakumäki has recently published his dissertation on the function of the left atrial receptors (26). He has studied the left atrial receptors by recording afferent activity in the vagus, as well as by recording sympathetic and vagal efferent activity. This work has an important bearing on the Bainbridge reflex which Hakumäki has shown to involve both increased sympathetic and decreased vagal activity to the heart. He is continuing further investigations of the left atrial reflexes.

Dr. Stenberg, working mainly in the area of Bergström's interests, is studying information transfer in primitive neural networks. The question of ontogenetic development arises here since the mammal has a similar network in the sympathetic nervous system. Stenberg is also looking into EEG development in the guinea pig fetus.

B. Turku

The Department of Physiology at this School is headed by Prof. Kaarlo Hartiala, who is currently the Rector of the University. As a result, Hartiala himself has not

been directly active in his laboratory to a great extent for the last couple of years. Nevertheless, he is able to maintain active direction of the work going on there. Hartiala came as first professor of physiology when the Medical School was new, about ten years ago, and showed a remarkable ability to develop both his own research and that of colleagues within the Department.

Hartiala's main interest has been in metabolic functions of the intestinal epithelium. He has shown in quite extensive physiological and biochemical studies that the intestine is in a sense a second "liver" in that it performs a great number of detoxifying functions. Largely through his work over the last several years the importance of the intestine in this sort of function has been generally recognized.

Some first-class neurophysiological work is being carried out by Dr. I. Lehtinen, who has recently been concerned, among other things, with the recruiting response of the thalamus.

As in many laboratories in Scandinavia, here too a strong emphasis is placed on research in physical fitness and exercise. Both experimental and statistical studies are carried out, many of them in collaboration with investigators in other departments of the University. Hartiala himself has an important position on the Finnish Olympic Committee in charge of medical and physiological activities.

The Department also contains a special cardiovascular research unit for human investigation. In addition to service activities for the hospital, one of the main interests of the group involved in this unit has been cardiovascular aspects of neonatal physiology. Until recently the unit was headed by Dr. L. Hirvonen, and much of the work was done in collaboration with Dr. T. Peltonen of the Department of Pediatrics. Hirvonen left Turku in 1971 to become Professor of Physiology at the new medical school of the University of Oulu, in the north of Finland.

APPENDIX

(1) N. Emmelin, J.R. Garrett and P. Ohlin, Neural control of salivary myoepithelial cells, J. Physiol. 196: 381-396 (1968)

(2) N. Emmelin, P. Ohlin and A. Thulin, The pharmacology of salivary myoepithelial cells in dogs, British Journal of Pharmacology 37, 3:666 (1969)

(3) N. Emmelin, J.R. Garrett and P. Ohlin, Action of kinins on salivary myoepithelial cells, J. Physiol. 207: 539-544 (1970)

(4) B. Folkow, M. Hallbäck, Y. Lundgren and L. Weiss, The effect of intense treatment with hypotensive drugs on structural design of the resistance vessels in spontaneously hypertensive rats, Acta physiol. scand. 83: 280-282 (1971).

(5) B. Folkow, The haemodynamic consequences of adaptive structural changes of the resistance vessels in hypertension, Clinical Science 41:1-12 (1971)

(6) B. Öberg and P. Thorén, Studies on cardiac ventricular receptors, Acta physiol. scand. 82:574-576 (1971)

(7) B. Öberg and P. Thorén, Increased activity in left ventricular receptors during hemorrhage or occlusion of caval veins in the cat, (submitted to Acta physiol. scand.)

(8) B. Öberg and P. Thorén, Studies on left ventricular receptors, signalling in non-medullated vagal afferents, (submitted to Acta physiol. scand.)

(9) M. Jodal and O. Lundgren, Plasma skimming in the intestinal tract, Acta physiol. scand. 80:50-60 (1970)

(10) B. Biber, O. Lundgren and J. Svanvik, Studies on the intestinal vasodilatation observed after mechanical stimulation of the mucosa of the gut, Acta physiol. scand. 82:177-190 (1971)

(11) K.L. Appelgren and D.H. Lewis, Capillary flow and capillary transport in dog skeletal muscle in hemorrhagic shock, Europ. Surg. Res. (in press)

(12) K.L. Appelgren and D.H. Lewis, Capillary flow and capillary transport in dog skeletal muscle in an experimental shock model (laparatomy and exteriorisation of the small intestine), Europ. Surg. Res. (in press)

(13) L. Edwall and M. Kindlová, The effect of sympathetic nerve stimulation on the rate of disappearance of tracers from various oral tissues, Acta Odontologica Scandinavica 29, 4 (1971)

(14) L. Edwall and D. Scott, Jr., Influence of changes in microcirculation on the excitability of the sensory unit in the tooth of the cat, Acta physiol. scand. 82: 555-566 (1971)

(15) S. Landgren and H. Silfvenius, The projection of group I muscle afferents from the hindlimb to the contralateral thalamus of the cat, Acta physiol. scand. 80, 10A (1970)

(16) J. Boivie, G. Grant and H. Silfvenius, A projection from the nucleus Z to the ventral nuclear complex of the thalamus in the cat, Acta physiol. scand. 80, 11A (1970)

(17) H. Silfvenius, Projections to the cerebral cortex from afferents of the interosseous nerves of the cat, Acta physiol. scand. 80:196-214 (1970)

(18) Å.B. Vallbo, Discharge patterns in human muscle spindle afferents during isometric voluntary contractions, Acta physiol. scand. 80:552-566 (1970)

(19) Å.B. Vallbo, Muscle spindle response at the onset of isometric voluntary contractions in man. Time difference between fusimotor and skeletomotor effects, J. Physiol. 218:405-431 (1971)

(20) R.M. Bergström, An entropy model of the developing brain, Developmental Psychobiology 2 (3):139-152 (1969)

(21) R.M. Bergström, Electrical parameters of the brain during ontogeny, Brain and Early Behaviour (Academic Press, London, 1969)

(22) R.M. Bergström, Unit spike activity in the coelenteran neural network, Die Naturwissenschaften 58, No. 3, p. 153 (1971)

(23) J. Kyvärinen, A. Poranen, Y. Jokinen, R. Näätänen and I. Linnankoski, Observations on unit activity in the primary somesthetic cortex of behaving monkeys (in press)

(24) H.S.S. Sarajas and P.T.S. Putkonen, Central nervous and visceral reaction patterns in rabbits warming up from deep hypothermia, Annales Academiae Scientiarum Fennicae A, IV Biologica, 144 (1968)

(25) P.T.S. Putkonen and A-R. Putkonen, Suppression of paradoxical sleep (PS) following hypothalamic defence reactions in cats during normal conditions and recovery from PS deprivation, Brain Research (Elsevier Publishing Company, Amsterdam, 1970)

(26) M.O.K. Hakumäki, Function of the left atrial receptors, Acta Physiologica Scandinavica, Supplementum 344 (1970)

(11) A. Jancsó-Gabor, J. Szolcsányi and N. Jancsó, Irreversible impairment of thermoregulation induced by capsaicin and similar pungent substances in rats and guinea-pigs, J. Physiol. 206:495-507 (1970)

(12) A. Jancsó-Gabor, J. Szolcsányi and N. Jancsó, Stimulation and desensitization of the hypothalamic heat-sensitive structures by capsaicin in rats, J. Physiol. 208: 449-459 (1970)

(13) J. Szolcsányi, F. Joó, A. Jancsó-Gabor, Mitochondrial changes in preoptic neurones after capsaicin desensitization of the hypothalamic thermodetectors in rats, Nature 229, 5280, pp. 116-117 (1971)

(14) G. Székely and G. Czéh, Muscle activities of partially innervated limbs during locomotion in ambystoma, Acta Physiologica Academiae Scientiarum Hungaricae 40 (3-4), pp. 269-286 (1971)

(15) G. Czéh and G. Székely, Muscle activities recorded simultaneously from normal and supernumerary forelimbs in ambystoma, Acta Physiologica Academiae Scientiarum Hungaricae, 40 (3-4), pp. 287-301 (1971)

(16) G. Székely and G. Czéh, Activity of spinal cord fragments and limbs deplanted in the dorsal fin of urodele larvae, Acta Physiologica Academiae Scientiarum Hungaricae, 40 (3-4), pp. 303-312 (1971)

(22) R.M. Bergström, Unit spike activity in the coelenteran neural network, Die Naturwissenschaften 58, No. 3, p. 153 (1971)

(23) J. Kyvärinen, A. Poranen, Y. Jokinen, R. Näätänen and I. Linnankoski, Observations on unit activity in the primary somesthetic cortex of behaving monkeys (in press)

(24) H.S.S. Sarajas and P.T.S. Putkonen, Central nervous and visceral reaction patterns in rabbits warming up from deep hypothermia, Annales Academiae Scientiarum Fennicae A, IV Biologica, 144 (1968)

(25) P.T.S. Putkonen and A-R. Putkonen, Suppression of paradoxical sleep (PS) following hypothalamic defence reactions in cats during normal conditions and recovery from PS deprivation, Brain Research (Elsevier Publishing Company, Amsterdam, 1970)

(26) M.O.K. Hakumäki, Function of the left atrial receptors, Acta Physiologica Scandinavica, Supplementum 344 (1970)